REMARKS

A Supplemental Information Disclosure Statement is being filed by regular mail concurrently with this response or within one business day thereof. Applicants accordingly encourage the Examiner to consider the Supplemental Information Disclosure Statement when evaluating this response.

The Novelty Rejections

Original Claim 1 recites an isotype heterostructure, i.e., the cladding layers and the active layer are all of the same conductivity type. This original claim recites a p-n junction formed with a top n-type cladding layer and a p-type layer thereon such that the p-n junction is removed from the active layer.

The Examiner has rejected independent Claim 1 and dependent claims 2, 4, and 6 as being anticipated by Udagawa '894.

The Applicants amend Claim 1 to include the additional features of a silicon carbide substrate and a conductive buffer layer. Amended Claim 1 also recites that the first n-type cladding layer is enclosed on either side by the conductive buffer layer and the active layer with no intervening layers separating the buffer, first cladding, and active layers.

In light of these claim amendments, the Applicants respectfully submit that the Examiner's rejection is critically flawed. The Examiner attempts to use Udagawa '894 as showing a heterostructure in which the cladding layers and the active layer are all of the same conductivity type. In this regard, the Examiner cites Udagawa '894, Figure 14, Reference Numbers 106 and 118 as n-type cladding layers around an n-type active layer, Reference Number 109.

Figure 14, Reference Number 106, however, is not a cladding layer. Reference Number 106 is the end portion of a superlattice structure that Udagawa '894 discloses in the position between a lower cladding layer and the active layer. Udagawa '894 uses this superlattice (104) as a foundation for improving the quality of the crystals grown for the active layer. *See* Udagawa '894, Column 7, Lines 26–28. The superlattice of Udagawa '894

consists of alternating layers of n-type Group III nitrides (Udagawa '894, Column 7, Lines 34–57). Udagawa '894's Reference 106 is not a cladding layer, but is only part of a "base" for growing the active layer (Udagawa '894, Column 10, lines 31–33). This base layer has no quantum effect (Udagawa '894, Column 12, Lines 23–24), indicating that the superlattice base region, Reference Number 106, has no effect on the position or energy states of the carriers.

The cladding layer of the Applicants' invention must have sufficient bandgap properties, as claimed, to confine the recombining carriers in the active region for proper luminescence. Udagawa admits that Reference Number 106 of the '894 patent has no quantum effect at all (Udagawa '894, Column 12, Lines 23–24). Udagawa '894, therefore, does not disclose any means by which Reference Number 106, the top layer of a superlattice base, could serve as a cladding layer that will confine carriers as desired.

Udagawa also fails to require that the top layer of the superlattice structure, Reference Number 106, and the crystal layer, Reference Number 118, have respective bandgaps that are larger than that of the active layer, as recited in the claim. In fact, the superlattice of Udagawa is extremely conductive (Udagawa '894, Column 7, Lines 36–40) and is useful for allowing carrier current, as opposed to confining carriers as necessary in the Applicants' invention. The crystal layer 118, which the Examiner cites as a top n-type cladding layer, is actually designed to allow electron tunnelling (Column 16, Lines 57–60). Layer 118 would be an ineffective cladding layer, as tunnelling is inapposite to the Applicants' requirement that a cladding layer confine electrons and holes in the active layer. Udagawa '894, therefore, teaches against the use of the crystal layer 118 as a top cladding layer and superlattice layer 106 as a bottom cladding layer.

The cladding layers claimed by the Applicants have specific bandgap properties that enable the cladding layers to confine carriers to the active region for luminescent recombination. The end portion of the superlattice base, designated as Udagawa '894 Reference Number 106, and the crystal layer, Reference Number 118, have no known or

suggested bandgap properties to enable sufficient carrier confinement as required by amended Claim 1. Udagawa '894's Reference Numbers 106 and 118, therefore, are inapt to serve as cladding layers. The Applicants respectfully submit that the Examiner mistakenly relied upon Udagawa '894 as disclosing the recited cladding layers of amended independent Claim 1.

The superlattice disclosed in Udagawa '894 requires alternating layers of at least two Group III nitrides (Udagawa '894, Column 8, Lines 20–25). Udagawa '894's Reference Number 106 is inoperable without other layers (Reference No. 104) in combination with it. The Applicants' amended Claim 1, in contrast, recites that the first n-type cladding layer is in contact with the conductive buffer layer on one side and the active layer on the other. Claim 1 does not include intervening layers between the buffer, first cladding, and active layers.

The layer described as Udagawa '894, Reference Number 106 could not function as a cladding layer in the position required by amended Claim 1. Udagawa '894 requires Reference Number 106 to be in contact with another layer of the superlattice base, as opposed to being in contact with the conductive buffer layer. The cladding layers recited in Amended Claim 1 are, therefore, neither disclosed nor suggested by Udagawa '894.

Udagawa '894 fails to disclose or suggest the n-doped isotype heterostructure that the Applicants claim in independent Claim 1 and dependent claims 2, 4 and 6.

Combining Udagawa and Schetzina under U.S.C. § 103

The Examiner proposes that the Applicants' original Claims 3, 5, and 7-14 are not patentable over Udagawa '894 in view of Schetzina '464.

The Applicants respectfully assert that Udagawa '894 and Schetzina '464 are incompatible references that cannot be combined to successfully show that Claims 3, 5, and 7–14 are obvious. Udagawa '894 utilizes a superlattice base structure for growing the active layer. The active layer has a conduction band and a valence band that intentionally bend toward the Fermi level at the junctions with surrounding layers. *See* Udagawa '894, Column 10, Lines 43–58. Udagawa '894 utilizes a sharp change in composition between the active

layer and the surrounding layers to achieve a non-rectangular potential structure within the active layer. *See* Udagawa '894, Column 15, lines 60–65. This non-rectangular potential structure within the active layer is a key feature of Udagawa '894 that allows it to emit light of various wavelengths. *See* Udagawa '894, Column 16, Lines 7–15. Udagawa '894's Figures 13–14 illustrate how Udagawa '894 takes advantage of strategically placed compositional changes among the layers to achieve an active layer with bent bands that control carrier recombination.

Schetzina '464, in contrast, seeks to minimize the sharp changes in composition that Udagawa '894 relies upon for proper operation. Schetzina '464 uses continuous grading and step-graded superlattices to minimize band offsets between the cladding layers and the contact layers. *See* Schetzina '464, Column 12, Lines 24–29. Udagawa '894 actually seeks to ensure the presence of band offsets by bending the active layer bands. *See* Udagawa '894, Column 9, Lines 40–46. Udagawa '894, therefore, relies upon the band offsets that Schetzina '464 intentionally minimizes. Schetzina '464, therefore, has a theory of operation that is entirely opposite from that of Udagawa '894.

Udagawa '894 and Schetzina '464 could not have been combined by one of skill in the art to obviate the Applicants' claimed invention. The Applicants respectfully state that Udagawa '894 and Schetzina '464 should not be combined to formulate a rejection in this case because there would have been no motivation to combine the references at the time of the Applicants' invention.

Specific Obviousness Rejections: Udagawa in view of Schetzina

The Examiner relies upon the continuously graded contact layers (Reference 122a, 122b) of Schetzina '464, combined with the Udagawa '894 reference, to reject the Applicants' continuously graded cladding layers in an isotype heterostructure, as recited in original Claim 3, and the third n-type layer, recited in original Claim 13.

Schetzina '464 neither discloses nor suggests grading the upper cladding layer to match the lattice of the active layer on one side and the p-type layer on the other side. Likewise, Schetzina '464 neither discloses nor suggests grading a lower cladding layer to match the lattice of the substrate on one side and the active layer on the other.

Schetzina '464 focuses on graded layers to provide low resistance electronic links between AlGaN cladding layers, GaN intermediate layers, and external electrodes. *See* Schetzina '464, Col. 10, Lines 60–65. Schetzina seeks to lower the resistance between layers and promote current flow. Schetzina's low resistance design actually teaches away from the Applicant's graded cladding layers. The Applicants' claimed cladding layers have specific bandgap properties to confine carriers in the active region, as opposed to Schetzina's goal of conducting all of the carriers through the device. Grading a cladding layer is entirely outside the scope of Schetzina '464. This deficiency in Schetzina '464 prohibits its use as a reference against original Claims 3 and 13 in this case.

The Examiner relies upon Schetzina '464 to reject Claims 5 and 7–12 regarding the p-type layer. The Applicants recite distinct embodiments of the p-type layer, including superlattices. Schetzina '464 discloses a p-type layer with a step graded, multiple quantum well structure using layers of AlGaN and GaN. *See* Schetzina '464, Figure 5. This structure is specifically engineered to reduce or eliminate the conduction band offset between AlGaN cladding layers and GaN contact layers. *See* Schetzina '464, Column 13, Lines 46–49. Schetzina '464 requires that the layers be of varying widths to function as disclosed. *See* Schetzina '464, Column 13, Lines 48–53.

The Applicants, on the other hand, claim a p-type layer of InN (original Claim 9), InGaN (original Claim 10), or a superlattice structure comprising layers of GaN, InN, and InGaN (original Claims 11 and 12). Schetzina '464 fails to disclose or suggest any use of indium in the contact layer. It would not have been obvious to one skilled in the art at the time of Applicants' invention to replace the AlGaN contact layers of Schetzina '464 with the indium based p-type layers as disclosed by the Applicants. The Applicants' p-type layers

would have entirely different electrical properties that could not be predicted from the disclosure of Schetzina '464.

Additionally, the Examiner's specific rejections of Claims 8 and 11 are insufficient to defeat the patentability of the claims in light of the above noted arguments in regard to Claims 5, and 7–12.

Specific Obviousness Rejections: Udagawa in view of Schetzina and Edmond

The Examiner adds Edmond '617 to the combination of Udagawa and Schetzina to allegedly defeat the patentability of original dependent Claims 15–21. These claims recite discrete crystal portions between the first n-type cladding layer and the silicon carbide substrate. Claims 15 and 17 have been canceled as noted above because the limitations therein are now part of Claim 1. The remaining claims, specifically Claims 16, 18, and 19–21, are in condition for allowance, as they depend from Claim 1, which is patentable as noted above.

Furthermore, Udagawa '894, Schetzina '464, and Edmond '617, analyzed alone or in combination, fail to disclose all of the elements of Claims 15–21. The three references are ineffective to show the claimed isotype heterostructure with the discrete crystal portions in place. In fact, Edmond '617 offers no disclosure placing the discrete crystal portions in the context of an isotype heterojunction device. Edmond '617 states only that "the active layer 33 as discussed herein can represent a device with a single p-n junction, a single or double p-n heterojunction or a p-n junction quantum well structure" (Detailed Description, Page 5, lines 22-24). A general statement regarding the devices in which the claimed discrete crystal portions prove useful is insufficient to overcome the patentability of the claims presented in the instant case.

Amended Claim 16, and its dependent claims, recite an isotype heterostructure on a substrate with the discrete crystal portions present in sufficient amount to reduce the barrier between the n-doped isotype heterostructure and the silicon carbide substrate. Udagawa '894,

RECEIVED
CENTRAL FAX CENTER

SEP 1 1 2003

OFFICIAL

Schetzina '464, and Edmond '617 fail to disclose or suggest these elements and should not be cited as prior art in regard to the pending claims.

Conclusions

In light of the foregoing amendments and arguments regarding the cited art, the Applicants consider the amended claims to be in condition for immediate allowance. The Applicants respectfully request that the Examiner reconsider the currently standing rejections and issue a favorable response to this submission.

Respectfully submitted,

Philip Summa
Reg. No. 31,573

021176
SUMMA & ALLAN, P.A.
11610 North Community House Road
Suite 200, Ballantyne Corporate Park
Charlotte, NC 28277-2162
Phone: 704-945-6715
Fax: 704-945-6735
S:\FIRM DOCS\5000\137\Resp-Amd070103.doc

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being transmitted by facsimile to the Commissioner for Patents, (Examiner Sara W. Crane; c/o Technology Center 2800 at Official Facsimile No. 703-872-9318) on September 11, 2003

9/11/2003
Date

Philip Summa